RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS

Meeting #9

Action Item 8-5
The Effects of a Smaller Amplitude Tolerance on Reception Performance with Mode S and Mode A/C Fruit

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SUMMARY

The enhanced decoding techniques defined in Appendix I suggest using a +/- 3 dB amplitude tolerance band when matching data pulses to the preamble amplitude. Action item 8-5 was assigned to examine the effects of tightening the amplitude tolerance to +/- 2 dB and +/- 1 dB and testing with Mode S and Mode A/C Fruit. This paper contains data from performing a subset of the Enhanced Surveillance Processing Test Procedures with the tighter tolerances.

Introduction

The enhanced decoding techniques defined in appendix I suggest using a +/- 3 dB amplitude tolerance band when matching data pulses to the preamble amplitude reference level. The Enhanced Decoding techniques use the amplitude of samples in the data block to determine which bit half (or chip) contains the transmitted pulse. Those samples that are within the tolerance band are considered most likely associated with a pulse that is part of the signal being demodulated. Action item 8-5 was assigned to examine the effects of tightening the amplitude tolerance to +/- 2 dB and +/- 1 dB and testing with Mode S and Mode A/C Fruit. This paper contains data from performing a subset of the Enhanced Surveillance Processing Test Procedures with the tighter tolerances.

Mode S Fruit

The test data with the Mode S Fruit relative amplitude varied in 1 dB steps was re-processed with the decoder software modified to use both a +/- 2 dB tolerance and a +/- 1 dB tolerance window in the bit and confidence declaration process. The data was processed with both the 5-5 table technique and the improved multiple sample technique. The data is presented in figures 1 and 2.

Tol.	Avg. Recept.
3	46.61
2	50
1	53.64

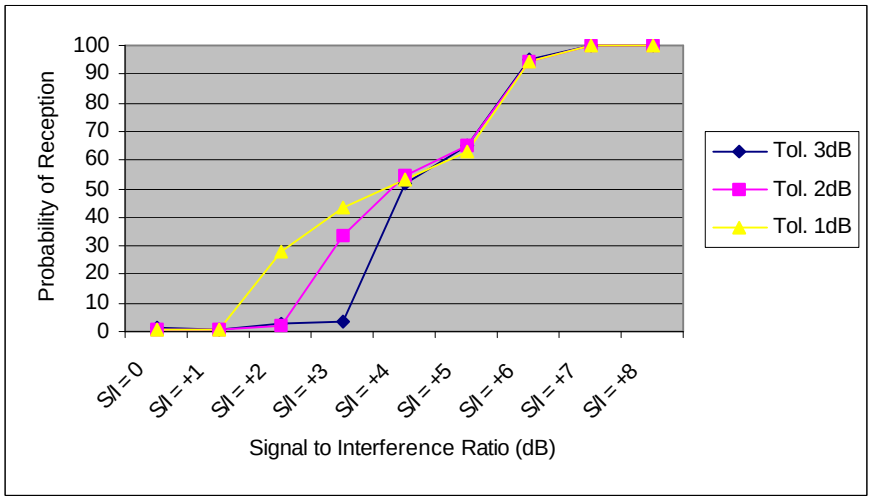

Figure 1 – Reception Rate with Mode S Fruit Using the 5-5 Enhanced Reception Technique

Tol.	Avg. Recept
3	46.66
2	48.86
1	49.8

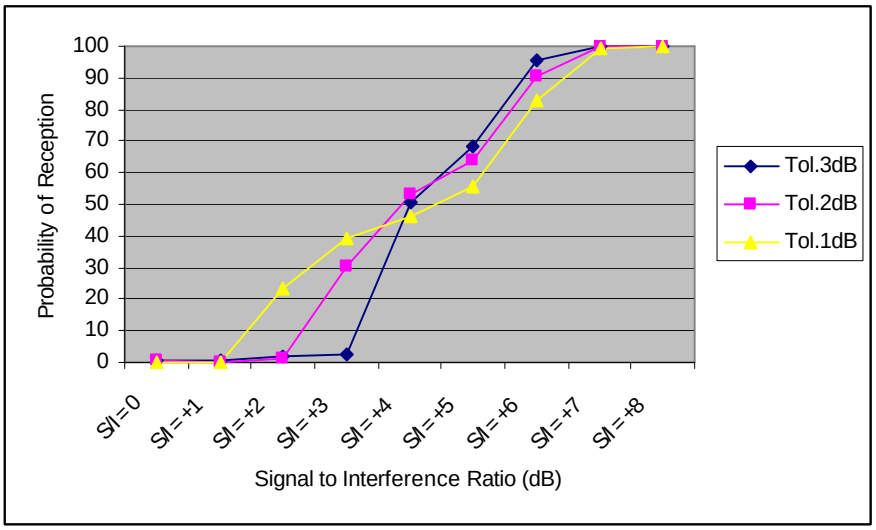

Figure 2 – Reception Rate with Mode S Fruit Using the Improved Multiple Sample Technique

There is a slightly different effect in the performance between the two reception techniques with the Mode S fruit. However in both cases, the performance improves slightly overall as the tolerance is tightened. The increase in overall performance is due to the ability to distinguish between the signal and fruit earlier in the signal to interference relative amplitude progression. The width of the tolerance band defines the minimum relative amplitude difference where the decoder will be able to distinguish signal from interference. The trade-off is that when the tolerance band is tightened the margin for error in declaring the preamble reference level is also tightened. Receiver bandwidth will also affect the performance with various tolerance levels. With this data, the fruit was prevented from overlapping the preamble and the signal levels were quite high (centered at –50 DBM). These factors will result in a consistent and accurate preamble reference level declaration and therefore performance will increase as the tolerance band is tightened. A fairer assessment of the effect would be with the combined preamble and data block test. The results of the test with 5 fruit with both data block and combined preamble and data block tests are shown below.

Mode A/C Fruit – 5 Fruit Data, Data Block Only

The test data with 5 Mode A/C fruit was re-processed with decoder software modified to use both a +/- 2 dB tolerance and a +/- 1 dB tolerance window in the bit and confidence declaration process. The data was processed with both the 5-5 table technique and the improved multiple sample technique. The data is presented in figures 3 and 4.

Tol.	Avg. Recept
3	75.91
2	77.53
1	75.96

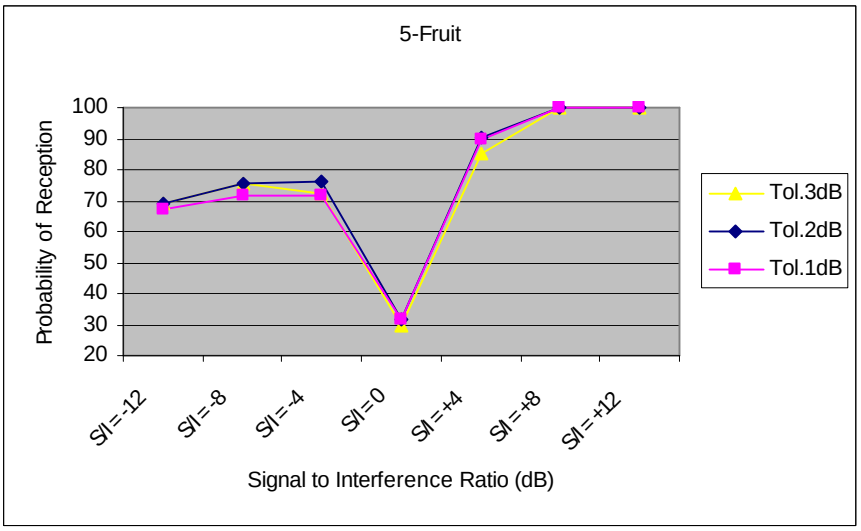

Figure 3 – Reception Rate with 5 Mode A/C Fruit using the 5-5 Enhanced Reception Technique.

Tol.	Avg. Recept
3	78.06
2	79.27
1	79.24

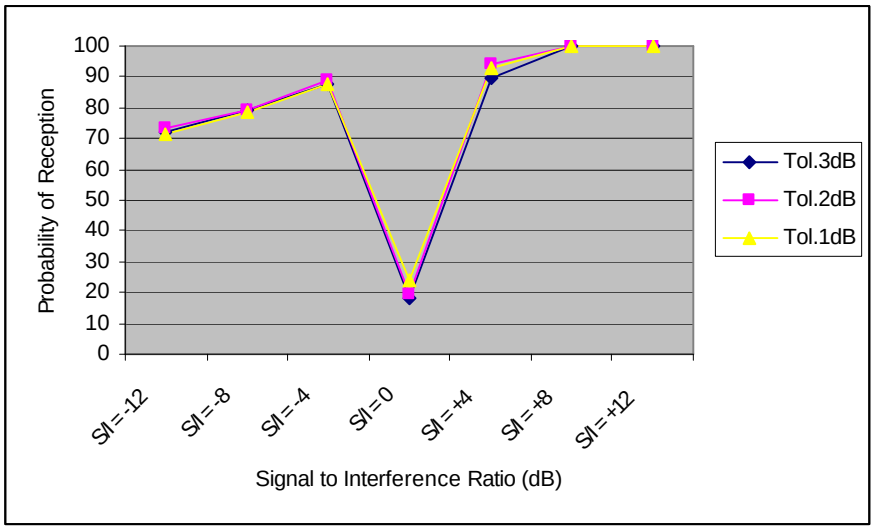

Figure 4 – Reception Rate with 5 Mode A/C Fruit using the Improved Multiple Sample Technique

Mode A/C Fruit – 5 Fruit Data Combined Preamble Data Block Test

The Combined Preamble Data Block Test data with 5 Mode A/C fruit was re-processed with decoder software modified to use both a +/- 2 dB tolerance and a +/- 1 dB tolerance window in the bit and confidence declaration process. The data was processed with both the 5-5 table technique and the improved multiple sample technique. The data is presented in figures 5 and 6.

Tol.	Avg. Recept
3	81.7
2	82.63
1	80.86

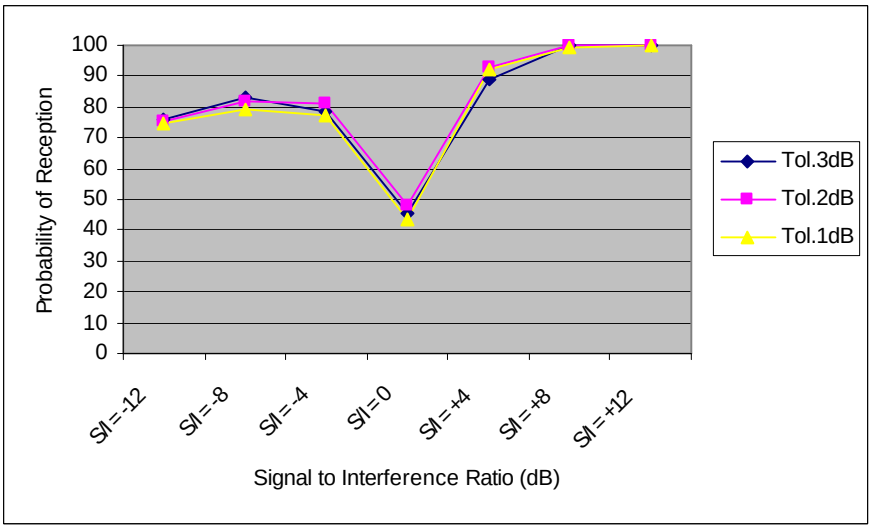

Figure 5 – Reception Rate with 5 Mode A/C Fruit Combined Preamble Data Block Test using the 5-5 Enhanced Reception Technique.

Tol.	Avg. Recept
3	82.19
2	83.11
1	83.03

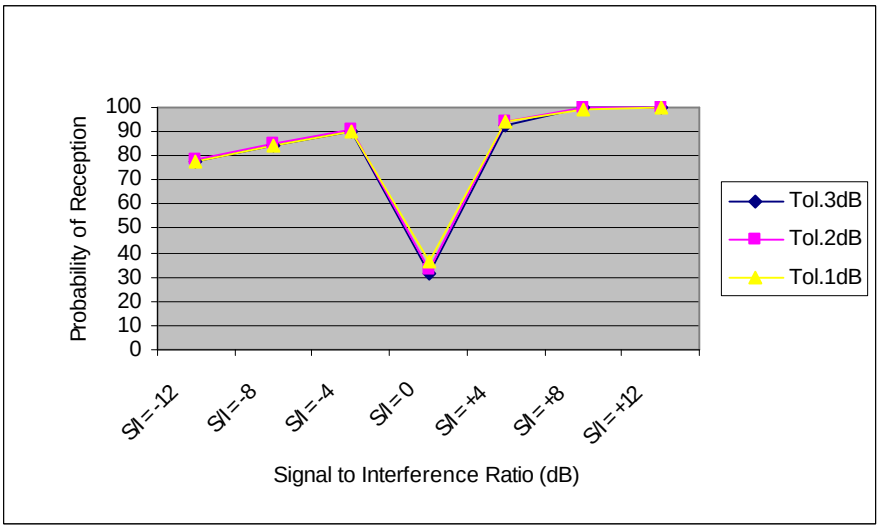

Figure 6 – Reception Rate with 5 Mode A/C Fruit Combined Preamble Data Block Test using the Improved Multiple Sample Technique